RADIOLOGIC HEALTH BRANCH
RADIOLOGICAL ASSESSMENT UNIT

DATE: June 26, 2013

TO: Jerry Hensley
Chief, Strategic Planning and Quality Assurance Section

FROM: Roger K. Lupo, Chief, Radiological Assessment Unit
Victoria Brandt, Associate Health Physicist

SUBJECT: RAU Staff Soil Sampling, Treasure Island, Site 12
March 20-21, 2013

UPDATE: September 23, 2013

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ABBREVIATIONS, DEFINITIONS AND EQUATIONS

cm	Centimeter
cpm	Counts per minute
DWRLB	Drinking Water and Radiation Laboratory Branch
GPS	Global positioning system
hr	hour
MCA	Multi-channel analyzer
MDA	Minimum detectable activity
MDA_{95}	Minimum detectable activity at the 95% confidence level
mm	Millimeter
NaI	Sodium Iodide, doped with Thallium, used in scintillation detector
NIST	National Institute of Standards and Technology
NORM	Naturally occurring radioactive materials
pCi/g	pico curies per gram, unit of concentration
R	roentgen, measure of radiation energy absorption per unit mass of air
RAU	Radiological Assessment Unit
RHB	Radiologic Health Branch
ROI	Radionuclide of Interest, plural ROIs
σ	Sigma is the standard deviation, Std. Dev. of the measurements of interest.
Std. Dev.	Standard Deviation, $\sigma = \sqrt{\frac{\Sigma_i (x_i - x_{avg})^2}{N-1}}$

where x_i is measurement, N is number of measurements; x_{avg} is the average of all measurements.

TI	Treasure Island

RAU Staff Soil Sampling, Treasure Island, Site 12

INTRODUCTION

The Radiological Assistance Unit (RAU) assisted with the onsite Treasure Island (TI), Site 12 survey effort by collecting soil samples at five locations with exposure rate measurements significantly exceeding background measurements. Radiologic Health Branch (RHB) surveyors found these locations using Ludlum Model 19 exposure rate instruments, labeled A – F, during surveys on March 18-19, 2013. RAU sent soil samples to the Drinking Water and Radiation Laboratory Branch (DWRLB) for gamma spectroscopic analysis following 21-day ingrowth.

SAMPLING DATES

March 20-21, 2013

SURVEY STAFF

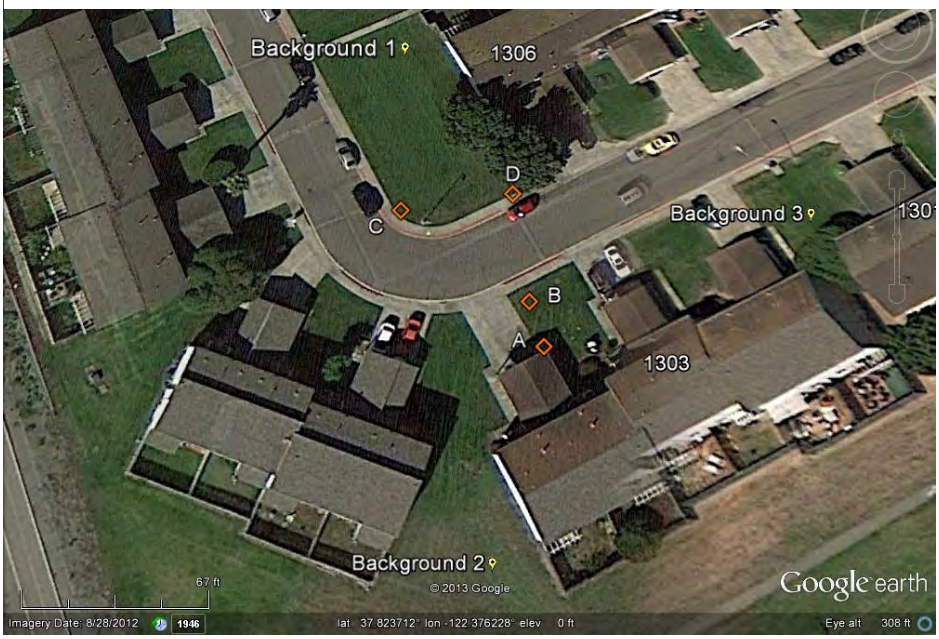
The following Radiological Assessment Unit Health Physicists performed surveys:

- Roger Lupo, supervisor, lead sampler
- Jeff Wong, surveyor, sampler
- Victoria Brandt, recorder, sample custodian
- Rajiv Mishra, surveyor

SURVEY LOCATIONS: TREASURE ISLAND, SITE 12

RAU staff collected soil samples in two general locations. Location 1 was in the curve of Gateview Avenue, west of the Avenue B intersection. Surveyors found four elevated measurement points, labeled A – D, in this location, see Figure 1: Treasure Island, Site 12, Gateview Avenue, Location 1.

Figure 1: Treasure Island, Site 12, Gateview Avenue, Location 1



Global Positioning System (GPS) data for each sample point was collected using a Garmin GPS device can be found in Table 1: GPS Data for Sample Points A - E. GPS data depends upon the particular instrument used; the tolerance of the particular instrument, and the satellites available at the time the measurement was collected. Re-measurement of the sample point locations can

vary within 10-40 feet.

Table 1: GPS Data for Sample Points A - E

Sample Point	Longitude	Latitude
A	W 122° 22.568’	N 37° 49.422’
B	W 122° 22.569’	N 37° 49.425’
C	W 122° 22.580’	N 37° 49.431’
D	W 122° 22.571’	N 37° 49.426’
E	W 122° 22.565’	N 37° 49.756’

Location 2 was in a green belt area southwest of the intersection of Gateview Avenue and Bayside Drive. One elevated measurement was found in this location.

Figure 2: Treasure Island, Site 12, Gateview Avenue, Location 2

SURVEY ACTIONS

At each point, A – E, RAU staff collected GPS data, see Table 1: GPS Data for Sample Points A - E, measurements with hand held radiation survey instruments and soil samples. Hand held survey equipment used see Table 2: Survey Instruments. The Ludlum Model 19 measurements were in units of micro roentgen per hour (µR/hr). The Ludlum Model 2221 measures on units of counts per minute (cpm).

Table 2: Survey Instruments

	Serial Number	Calibration Date	Type	Background
Ludlum Model 19	42969	14-Feb-2013	microR ratemeter	7 µR/hr
Ludlum Model 2221	163683		Scaler/Ratemeter †	
• Ludlum Model 44-10	PR169437	24-Aug-2012	• NaI scintillation detector	6832 cpm

† Count rates greater than 1,000,000 cpm were measured at 0.1 minute, and then converted to counts per minute (cpm).

RAU and Tetra Tech personnel attended the isolation of the radioactive fragment found at sample point E. Following isolation of the fragment, RAU and Tetra Tech personnel agreed that RAU would continue to location 1. Tetra Tech personnel would finish remediation

At each of points A – D, RAU isolated the point of greatest count rate using a 2"x2" NaI detector, cleared the sod, and then collected a soil sample. RAU mixed and divided each soil sample into two labeled bags, one for DWRLB analysis and one for Tetra Tech analysis. Before sampling, RAU decided if soil with radioactive fragment(s) was excavated during sampling, the split with the radioactive fragment(s) would be given to Tetra Tech. DWRLB subsequently identified fragments at sample point A and this sample was not given to the Navy's contractor.

LABORATORY ANALYSIS

All samples were analyzed using gamma spectroscopy following a minimum 21-day in-growth period by CDPH's Drinking Water and Radiation Laboratory Branch (DWRLB) Branch. RAU requested the in-growth period to optimize detection and characterization of radium 226, through analysis of gamma producing progeny bismuth 214 (Bi-214). Laboratory results are summarized following sampling actions for each sample point and summarized in Table 14: Laboratory Results Summary. For Minimum Detectable Activity (MDA) values for each sample, see copies of laboratory results can be found in Appendix B: Sample Analysis and Results.

The results of the laboratory analysis of soil samples collected in these five sample points show that some of the contamination was in the form of discrete particles, with Sample Point E having a larger metallic backed fragment, see Photo 3: Radioactive Fragment Detail. The soil contamination for other sample points may have originated with discrete particles, but no fragments were isolated by RAU's sampling. Radium contamination was identified in soil right below the grass and extending at least 30 cm (12 inches) below the grass. Vegetation growing over the radioactive fragments was not tested for radioactive contamination through uptake by the plant roots. Cesium 137 concentrations for nine samples were below the MDA. The Cs-137 concentrations in the remaining two samples were considered ambient background levels.

SPECIFIC SAMPLING AND LABORATORY RESULTS

Sampling actions for each sample point are discussed below, followed by the laboratory results for the sample(s) collected. All soil samples collected by RAU at Sample Points A-D were divided and, bagged for RAU laboratory analysis and for Tetra Tech.

SAMPLE POINT A

Sample point A lies near a concrete walkway adjacent to Building 1303, see Figure 1: Treasure Island, Site 12, Gateview Avenue, Location 1.Exposure rate measurements made at the location are summarized in Table 3: Data - Sample A. GPS location can be found in Table 1: GPS Data for Sample Points A - E. Following removal of the surface sod layer, RAU collected a soil sample from a 7-10 cm (3-4 inch) diameter hole at 15 cm (6 inch) depth.

The following day, Tetra tech personnel remediated sample point A by excavating a hole measuring approximately 45 cm by 45 cm by 30cm depth. RAU collected two soil samples, the first during remediation and the second following remediation.

Table 3: Data - Sample A

Detector height above sod	**Pre-remediation** Ludlum Model 19 (μR/hr)	**Pre-remediation** Ludlum Model 44-10 † (cpm)	**Post-remediation** (cpm)
Contact	1,600	$1.377x10^{6}$	$9.76x10^{3}$
30 cm	250	$2.72x10^{5}$	-----
100 cm	55	$5.59x10^{4}$	-----

† Count rates greater than 1,000,000 cpm were measured at 0.1 minute, and then converted to counts per minute (cpm). No dead time corrections were made.

Small discrete particles (3,500 μR/hr on contact) were collected by RAU during pre-remediation soil sampling (sample A) and sent to DWRLB. The radioactive fragments were sieved out of the soil during the standard sample preparation. The results of the laboratory analysis, with the radioactive fragments removed, are summarized in Table 4: Laboratory Results - Sample A. Cs-137 concentrations were less than MDA for all samples collected in this location.

Table 4: Laboratory Results - Sample A

Descriptive Name	Sample ID	Gamma Measurement (mR/hr)	Cs-137 Concentration (pCi/g)	Ra-226 Concentration (pCi/g)	K-40 Concentration (pCi/g)
Pre-Remediation					
Treasure Island Site 12, Sample A	R98805	3.5	-0.24†	7898	6.53
During Remediation					
TI Sample A – During Remediation	R96216	-----	-0.14†	706	10.6
Post-Remediation					
TI Sample A – Post Remediation	R96217	-----	0.00†	1.02	10.3

† Concentrations are less than the MDA.

Note that because of the much higher count rates for Sample A, see Table 4: Laboratory Results - Sample A, the MDA_{95} is much greater for all nuclides due to the greater concentration of the Ra-226 (Bi-214). This characteristic is inherent to the type and sensitivity of the detection equipment when counting such high concentrations and does not indicate failure of the instrument or analysis procedure.

SAMPLE POINT B

Sample point B was near the front sidewalk on the northern border of the lawn between the western most two driveways of building 1303; see Figure 1: Treasure Island, Site 12, Gateview Avenue, Location 1. GPS location can be found in Table 1: GPS Data for Sample Points A - E. Exposure rate measurements made at the location are summarized in Table 5: Data - Sample B.

The following day, Tetra Tech personnel remediated sample point B by excavating a hole measuring approximately 30 cm by 30 cm by 30cm depth. RAU collected one soil sample following remediation.

Table 5: Data - Sample B

Detector height above sod	**Pre-remediation** Ludlum Model 19 (μR/hr)	**Pre-remediation** Ludlum Model 44-10 † (cpm)	**Post-remediation** (cpm)
Contact	17	$1.61x10^{4}$	$7.62x10^{3}$
30 cm	-----	$8.01x10^{3}$	-----
100 cm	7.0	$6.78x10^{3}$	-----

The results of the laboratory analysis are summarized in Table 6: Laboratory Results - Sample B. Cs-137 concentrations were less than MDA for all samples collected in this location. The post-remediation Ra-226 concentrations are greater than expected for primordial concentration.

Table 6: Laboratory Results - Sample B

Descriptive Name	Sample ID	Gamma Measurement (mR/hr)	Cs-137 Concentration (pCi/g)	Ra-226 Concentration (pCi/g)	K-40 Concentration (pCi/g)
Pre-Remediation					
Treasure Island Site 12, Sample B	R98806	0.45	0.022†	100	10.6
Post-Remediation					
TI Sample B – Post Remediation	R96218	-----	0.036†	3.36	10.2

† Concentrations are less than the MDA.

SAMPLE POINT C

Sample point C was located next to the sidewalk, near the street corner, see Figure 1: Treasure Island, Site 12, Gateview Avenue, Location 1. Exposure rate measurements made at the location are summarized in Table 7: Data - Sample C. GPS location can be found in Table 1: GPS Data for Sample Points A - E. On March 20, 2013, following removal of the surface sod layer, RAU collected a soil sample from a 7-10 cm (3-4 inch) diameter hole at 15 cm (6 inch) depth. On the following day, Tetra Tech remediated this location and isolated a radioactive fragment.

Table 7: Data - Sample C

Detector height above sod	**Pre-remediation** Ludlum Model 19 (μR/hr)	**Pre-remediation** Ludlum Model 44-10 † (cpm)	**Post-remediation** (cpm)
Contact	240	$2.80x10^{5}$	$8.94x10^{3}$
30 cm	-----	$9.50x10^{4}$	-----
100 cm	28	$2.69x10^{4}$	-----

The results of the laboratory analysis, pre- remediation and post-remediation, are summarized in Table 8: Laboratory Results - Sample C. Cs-137 concentrations were less than MDA for all samples collected in this location. The post-remediation Ra-226 concentrations are greater than expected for primordial concentration.

Table 8: Laboratory Results - Sample C

Descriptive Name	Sample ID	Gamma Measurement (mR/hr)	Cs-137 Concentration (pCi/g)	Ra-226 Concentration (pCi/g)	K-40 Concentration (pCi/g)
Pre-Remediation					
Treasure Island Site 12, Sample C	R98807	0.45	0.02†	75.8	9.49
Post-Remediation					
TI Sample C – Post Remediation	R96219	-----	0.01†	38.0	9.89

† Concentrations are less than the MDA.

SAMPLE POINT D

Sample point D was near the sidewalk on Gateview Avenue, within the drip line of a large tree, see Figure 1: Treasure Island, Site 12, Gateview Avenue, Location 1, Exposure rate measurements made at the location are summarized in Table 9: Data - Sample D. GPS location can be found in Table 1: GPS Data for Sample Points A - E. A small radioactive fragment was collected during sampling. The split with the radioactive fragment was given to Tetra Tech for analysis and future disposal.

Table 9: Data - Sample D

Detector height above sod	**Pre-remediation** Ludlum Model 19 (μR/hr)	**Pre-remediation** Ludlum Model 44-10† (cpm)	**Post-remediation** (cpm)
Contact	33	2.96×10^4	6.07×10^3
30 cm	-----	9.38×10^3	-----
100 cm	7.0	6.27×10^3	-----

The results of the laboratory analysis are summarized in Table 10: Laboratory Results - Sample D. For this location there was no remediation performed, therefore there were no post-remediation samples collected. Cs-137 concentrations were greater than MDA for all samples collected in this location.

Table 10: Laboratory Results - Sample D

Descriptive Name	Sample ID	Gamma Measurement (mR/hr)	Cs-137 Concentration (pCi/g)	Ra-226 Concentration (pCi/g)	K-40 Concentration (pCi/g)
Pre-Remediation					
Treasure Island Site 12, Sample C	R98808	0.10	0.02	0.64	9.31
Post-Remediation					
No post-remediation sample collected.					

† Concentrations are greater than the MDA.

SAMPLE POINT E

Sample E was in the a greenbelt area southwest of the intersection of Gateview Avenue and Bayside Drive, approximately 6.1 meters (20 feet) from a bus stop bench, see Figure 2: Treasure Island, Site 12, Gateview Avenue, Location 2. Exposure rate measurements made at the location are summarized in

Table 11: Data - Sample Point E. GPS location can be found in Table 1: GPS Data for Sample Points A - E.

Tetra Tech personnel assisted in excavating sample E. A 30 cm by 30 cm square was cut in the sod, and then the sod block was flipped onto the plastic surrounding the hole. The sod block was approximately 11 cm thick. Measurement of the bottom of the sod indicated that the radioactive source was not in the sod block, Photo 1: Treasure Island, Site 12, Sample Point E, Sod Block.

Photo 1: Treasure Island, Site 12, Sample Point E, Sod Block

Soil dug from the hole was placed in clean 5-gallon buckets until the source was detected in a bucket. Incremental separation of the soil isolated the thin metallic radioactive fragment approximately 1.5 cm diameter see Photo 3: Treasure Island, Point E, Radioactive Fragment in Bucket and Photo 3: Radioactive Fragment Detail.

Table 11: Data - Sample Point E

Detector height above sod	**Pre-remediation** Ludlum Model 19 (μR/hr)	**Pre-remediation** Ludlum Model 44-10 † (cpm)	**Post-remediation** (cpm)
Contact	4,900	2.77×10^{6}	7.27×10^{3}
30 cm	-----	7.33×10^{5}	-----
100 cm	140	2.69×10^{4}	-----

† Count rates greater than 1,000,000 cpm were measured at 0.1 minute, and then converted to counts per minute (cpm). No dead time corrections were made.

Following isolation of the radioactive fragment, RAU staff and Tetra Tech personnel agreed to meet at Location 1, adjacent to the curve of Gateview Avenue, west of the Avenue B intersection, to sample points A – D. RAU staff volunteered to provide Tetra Tech personnel with splits of samples RAU collected. The Tetra Tech personnel decided to finish remediating the sample point E to background measurements, before moving on to Location 1.

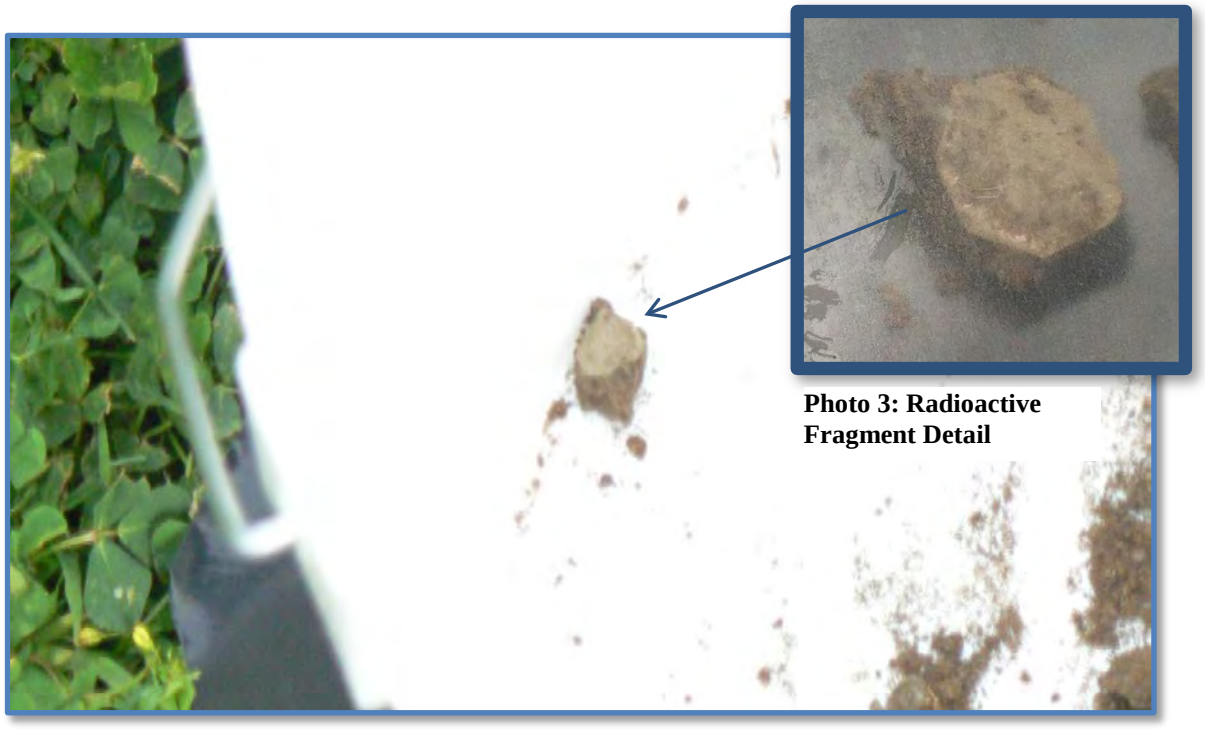


Photo 3: Radioactive Fragment Detail

Photo 3: Treasure Island, Point E, Radioactive Fragment in Bucket

The results of the laboratory analysis are summarized in Table 12: Laboratory Results - Sample E. For this location there was no remediation performed, therefore there were no post-remediation samples collected. Cs-137 concentrations were less than MDA for all samples collected in this location. The post-remediation Ra-226 concentrations are greater than expected for primordial concentration.

Table 12: Laboratory Results - Sample E

Descriptive Name	Sample ID	Gamma Measurement (mR/hr)	Cs-137 Concentration (pCi/g)	Ra-226 Concentration (pCi/g)	K-40 Concentration (pCi/g)
Pre-Remediation					
Treasure Island Sample E, Bottom	R98803	0.11	-0.03†	30.0	10.4
TI Sample E, Bottom of Sod, 11 cm depth	R98804	0.15	-0.06†	405	9.83
Post-Remediation					
TI Sample E – Post Remediation	R96215	-----	0.01†	6.79	10.9

† Concentrations are less than the MDA.

Before remediation, the exposure rate was 4,900 µR/hr on contact with the grass. A radioactive fragment appearing as a 1.5 cm octagonal radioactive disk was found, see Photo 3: Radioactive Fragment Detail. The maximum concentration found in the top 15 cm of soil was 405 pCi/g. A second

sample, ID R96215, collected from the bottom of the remediated hole at 20 cm depth had a radium concentration of 6.79 pCi/g.

VARSKIN 4 ANALYSIS – SAMPLE E

Of concern is the possible dose to the public, should an individual handle an unshielded radioactive fragment, such as the fragment found in Sample Point E. The potential beta dose to such an individual was modeled using the Varskin 4 software, assuming an irradiation time of one hour, one square centimeter skin irradiation area, and 2-millimeter source to skin distance. The beta and gamma radium emitting progeny bismuth 214 (Bi-214), lead 214 (Pb-214), lead (Pb-210), and bismuth 210 (Bi-210). Varskin uses a calculated "Source Strength" equal to source concentration per square centimeter. The photon dose rate combines the exposure of gamma and x-rays. The results are summarized in Table 13: Varskin Modeling Summary and the analysis can be found in Appendix C: Varskin Analysis.

Table 13: Varskin Modeling Summary

Isotope	Bi-214 (rad/hr)	Pb-214 (rad/hr)	Bi-210 (rad/hr)	Pb-210 (rad/hr)	All Sources (rad/hr)
Beta Dose Rate	420	721	450	0	1,590
Photon Dose Rate	3.5	1.9	0	1.4	6.8
Total	423	723	450	1.4	1,600

According to the Center for Disease Control (CDC) fact sheet titled "Cutaneous Radiation Injury: Fact Sheet for Physicians[1]" a one hour skin contact with the fragment could cause radiation burns, hair loss and possible ulceration.

[1] http://www.bt.cdc.gov/radiation/pdf/criphysicianfactsheet.pdf

CONCLUSION

The soil sampled was during a cursory survey of common areas surrounding residential units in Area 12. The RHB survey plan was designed to detect discrete radioactive fragments immediately below the surface, not distributed low-level radioactive soil contamination.

The results of the laboratory analysis of soil samples collected at these five locations with elevated measurements show radium soil contamination exists in soil above the depth of the actual source location. Locations where soil samples were collected at multiple depths showed vertical distribution of radium contamination. Additional remediation needs to be performed at locations B, C and E. In addition, additional sampling needs to be performed at location D since RHB collected no post-remediation samples. Soil sampling to establish the lateral or horizontal spread of radium contamination in the soil was beyond the scope of RAU's sampling plan. Additional sampling is necessary to evaluate the lateral radium contamination spread in the soil.

Argonne National Laboratory's RESRAD 6.5 computer dose modeling using the most conservative residential farmer model indicates that the predominant dose pathways for radium contamination in the soil are through plant ingestion and external gamma radiation. Vegetation growing over or near the radioactive fragments was not tested for radioactive contamination through uptake by the plant roots. Information provided to RHB indicates that gardening is not permitted by TI residents. Vegetation sampling was beyond the scope of the RAU survey.

Cesium 137 concentrations for nine samples were below the MDA. The Cs-137 concentrations in the remaining two samples were consistent ambient background levels.

Because the location of the radioactive fragments is inconsistent with the Historical Radiological Assessment (HRA) and the updates to the HRA, and because the fragments may have been deposited in those locations by prior construction activities and earthwork, it is recommended that the Navy perform a radiological characterization survey to identify and quantify low levels of radioactivity as soon as possible. To quantify accurately potential radiological exposures to TI residents, a detailed radiological dose model will need to be performed. Further evaluation should be made of the probability of a member of the public, especially critical members of the population (for example, children), picking up a radioactive fragment and being exposed.

Appendix A: CALIBRATION CERTIFICATES

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.

501 Oak Street
325-235-5494
Sweetwater, TX 79556, U.S.A.

☐ 231 Sam Rayburn Parkway
865-270-8962
Lenoir City, TN 37771, U.S.A.

CUSTOMER SUTTER HEALTH ORDER NO. 20216542/388117

Mfg. Ludlum Measurements, Inc. Model 19 Serial No. 42969

Mfg. _____ Model _____ Serial No. _____

Cal. Date 14-Feb-13 Cal Due Date 14-Feb-14 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 20 % Alt 701.8 mm Hg

☐ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☑ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☑ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 655 V Input Sens. 35 mV Det. Oper. _____ V at _____ mV Threshold Dial Ratio _____ = _____ mV

☐ HV Readout (2 points) Ref./Inst. _____ / _____ V Ref./Inst. _____ / _____ V

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
5000	4000 µR/hr	3500	4000
5000	1000 µR/hr	900	1000
500	400 µR/hr = 75800cpm	320	400
500	100 µR/hr	80	100
250	200 µR/hr = 37000cpm	160	200
250	100 µR/hr	70	105
50	7580 cpm	42	40
50	1890 cpm	10.2	10
25	3700 cpm	21	20
25	920 cpm	5.2	5

*Uncertainty within ± 10% C.F. within ± 20%

50, 25 **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 059 ☐ 280 ☐ 720 ☐ 734 ☐ 781 ☐ 1131 ☐ 1616 ☐ 1696 ☐ 5105 ☐ 5717CO ☐ 5719CO
☐ 60646 ☐ 70897 ☐ 73410 ☐ E551 ☐ E552 ☐ G112 ☑ M565 ☐ S-394 ☐ S-1054 ☐ T-304 ☐ T879 ☐ T10081 ☐ T10082 ☐ Y982

☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

☑ m 500 S/N 238275 ☐ Oscilloscope S/N _____ ☑ Multimeter S/N 70602489

Calibrated By: _____ Date 14 Feb 13

Reviewed By: _____ Date 15 Feb 13

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: _____

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
RADIOLOGIC HEALTH BRANCH
1500 Capitol Avenue, Sacramento, CA

Detector Efficiency

Meter:	Mfg. **Ludlum**	Model: **19**	Serial # **42969**	Calibration Date:	11-Jan-2012
Detector:	Mfg. **N/A**	Model: **N/A**	Serial # **None**	Due Date:	**Jan 2013**

NIST TRACEABLE SOURCES

Isotope	Serial #	Cert. Date	Activity	Units	DPM
Am-241	5588	3/1/2001	1.075	µCi	2345274
Ba-133	5589	3/1/2001	1.048	µCi	1137715
Cs-137	5590	3/1/2001	1.010	µCi	1746372

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology or to Physikalisch-Technische Bundesanstalt (PTE), to the extent allowed by the Institute's calibration facilities.

EFFICIENCY CALCULATIONS

Source Distance: 0.5 in.

Background Measurement microR/h		**Isotope: Am-241** Measurement microR/h	**Isotope: Ba-133** Measurement microR/h	**Isotope: Cs-137** Measurement microR/h
7.00	**1**	100.0	172.5	112.5
8.00	**2**	100.5	175.0	112.5
7.50	**3**	95.0	172.5	115.0
8.50	**4**	100.5	175.0	115.0
7.75	**5**	100.5	175.0	117.5
7.75	**Average** (microR/h)	**99.3**	**174.0**	**114.5**
0.56	**Std. Dev.** (microR/h)	2.4	1.4	2.1
	Efficiency	0.000039 (microR/h) /dpm	0.000146 (microR/h) /dpm	0.0000611 (microR/h) /dpm

% Efficiency	0.0039%	for	Am-241
% Efficiency	0.0146%	for	Ba-133
% Efficiency	0.0061%	for	Cs-137

COMMENTS: 4π Emission (DPM) is decayed to printing date.

Health Physicist: Victoria L Brandt
Victoria Brandt

Date: January 17, 2012

Reviewed By: Roger K Lyo

Date: 1.17.2012

Date Printed: 1/17/2012
Version 1.5.2

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
RADIOLOGIC HEALTH BRANCH
1500 Capitol Avenue, Sacramento, CA

Detector Response

Meter:	Mfg. **Ludlum**	Model: **19**	Serial # **42969**	Calibration Date:	14-Feb-2013
Detector:	Mfg. **N/A**	Model: **N/A**	Serial # **None**	Due Date:	**Feb 2014**

NIST TRACEABLE SOURCES

Isotope	Serial #	Cert. Date	Cert. Activity		Current Activity		DPM
Am-241	5588	3/1/2001	1.075	µCi	1.054	µCi	1
Cs-137	5590	3/1/2001	1.010	µCi	0.7662	µCi	1
Ra-226	5905	3/1/2001	1.021	µCi	1.016	µCi	1

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology or to Physikalisch-Technische Bundesanstalt (PTE), to the extent allowed by the Institute's calibration facilities.

RESPONSE CALCULATIONS

Source Distance: 0.5 in.

Background Measurement uR/hr		**Isotope: Am-241** Measurement uR/hr	**Isotope: Cs-137** Measurement uR/hr	**Isotope: Ra-226** Measurement uR/hr
5.5	**1**	100	100	340
6.25	**2**	105	100	345
6.5	**3**	100	103	335
6.25	**4**	100	105	340
6.5	**5**	100	95	330
6.2	**Average** (uR/hr)	**101**	**101**	**338**
0.4	**Std. Dev.** (uR/hr)	2	4	6
	Net Response	89.9 (uR/hr) /µCi	123.2 (uR/hr) /µCi	326.7 (uR/hr) /µCi

COMMENTS: Emission (DPM) is decayed to printing date.

Health Physicist: Victoria L Brandt
Victoria Brandt
Date: March 11, 2013

Reviewed By: Roger K Lyze
Date: 3.11.2013

Date Printed: 3/11/2013

Response Check (3)

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
RADIOLOGIC HEALTH BRANCH
1500 Capitol Avenue, Sacramento, CA

Certificate of Calibration

Meter:	Mfg. **Ludlum**	Model: **2221**	Serial # **163683**	Date:	24-Aug-2012
Detector:	Mfg. **Ludlum**	Model: **44-10**	Serial # **PR169437**	Due Date:	**Aug 2013**

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Sources

Isotope	Serial #	Cert. Date	Activity	Units	DPM
Am-241	5588	3/1/2001	1.075	µCi	2343013
Ba-133	5589	3/1/2001	1.048	µCi	1093539
Cs-137	5590	3/1/2001	1.010	µCi	1722377

Reference Equipment

Mfg	Model	Serial #	Cal. Due Date
Ludlum	**500**	142041	3/31/2013

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology or to Physikalisch-Technische Bundesanstalt (PTE), to the extent allowed by the Institute's calibration facilities.

X	Battery Ck.	**X**	Mech. Ck.	**N/A**	Zero Ck.	**X**	Geotropism	**N/A**	Overload
		X	Audio Ck.	**X**	Reset Ck.	**X**	Fast/Slow	**X**	Window Op.

"As Found" HV 1016 V Temperature 72.6 °F Final Voltage 1017 V

Threshold 10 mV Window 10.0 mV

HV Readout: Pulser Ref. 500 V Pulser Ref. 1800 V

Meter 508 V ± 2% Meter 1797 V ± 2%

ANALOG RATEMETER READOUT

Pulser Frequency	Range Multiplier	"As Found" Reading	Corrected Reading	Correction Factor *
500 CPM	LOG	505 CPM	--- CPM	*Indication only*
500,000 CPM	LOG	500 CPM	--- CPM	*Indication only*
400,000 CPM	x 1K	410 CPM	400 CPM	1.00
100,000 CPM	x 1K	110 CPM	100 CPM	1.00
40,000 CPM	x 100	400 CPM	CPM	1.00
10,000 CPM	x 100	100 CPM	CPM	1.00
4,000 CPM	x 10	400 CPM	CPM	1.00
1,000 CPM	x 10	100 CPM	CPM	1.00
400 CPM	x 1	400 CPM	CPM	1.00
100 CPM	x 1	100 CPM	CPM	1.00

DIGITAL SCALER READOUT

Pulser Reference	"As Found" Reading	Correction Factor
40,000 CPM	39932 CPM	1.00

* Uncertainty ± 10% Correction Factor within ± 20%

COMMENTS: Calibration Interval = 1 year 4π Emission (DPM) is decayed to printing date.

Attached Documents: ☑ *Plateau Graph* ☑ *Efficiency*

Calibrated By: Victoria L Brandt
Victoria Brandt

Date: August 24, 2012

Reviewed By: Roger Klyn

Date: 8/24/12

Date Printed: 8/24/2012
Version 1.5.2

CAL RNIA DEPARTMENT OF PUBLIC I LTH
RADIOLOGIC HEALTH BRANCH
1500 Capitol Avenue, Sacramento, CA

Detector Plateau Graph

Meter:	Mfg. **Ludlum**	Model: **2221**	Serial #	**163683**	Date:	24-Aug-2012	
Detector:	Mfg. **Ludlum**	Model: **44-10**	Serial #	**PR169437**	Due Date:	**Aug 2013**	

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Sources

Isotope	Serial #	Cert. Date	Activity	Units	DPM
Cs-137	5590	3/1/2001	1.010	µCi	1722377

Reference Equipment

Mfg	Model	Serial #	Cal. Due Date
Ludlum	**500**	142041	3/3/2012

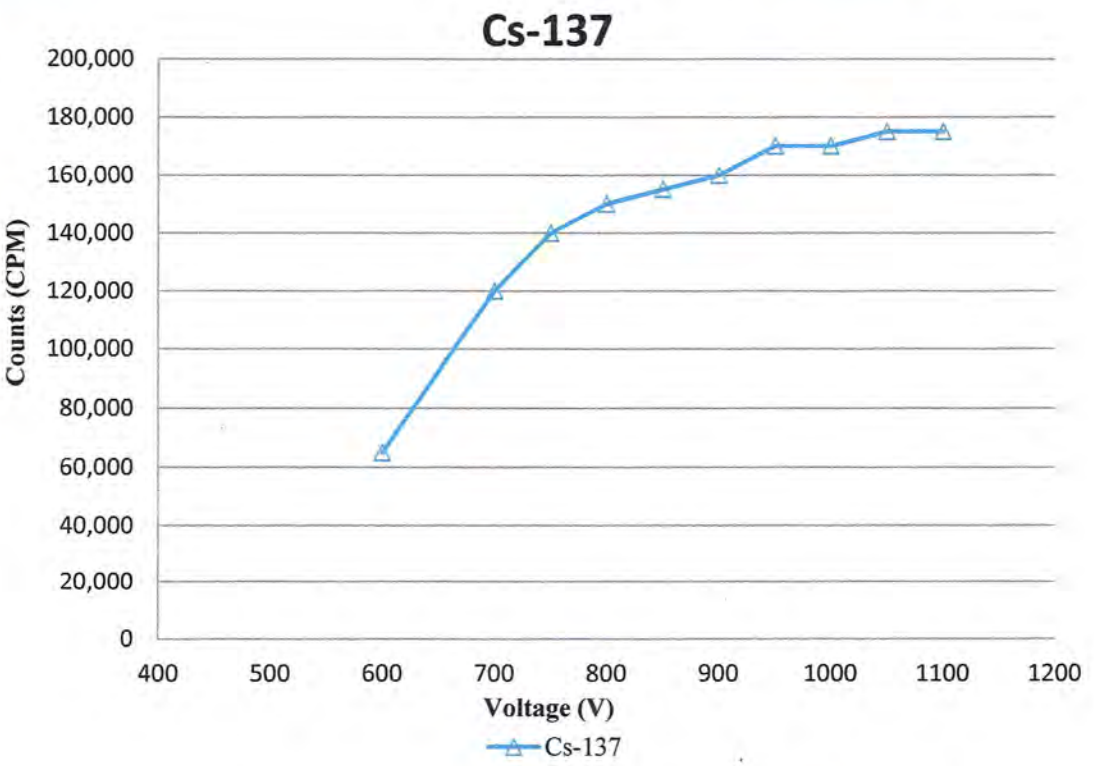
Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology or to Physikalisch-Technische Bundesanstalt (PTE), to the extent allowed by the Institute's calibration facilities.

PLATEAU GRAPH

Distance to Source 0.50 in.

As Found HV 1016 V

Voltage (V)	Cs-137 (CPM)
600	65000
700	120000
750	140000
800	150000
850	155000
900	160000
950	170000
1000	170000
1050	175000
1100	175000



HV Range between knee+ 25V and knee + 50V

Final HV ***1017*** V

COMMENTS: 4π (DPM) Emission is decayed to printing date.

Health Physicist: Victoria L Brandt
Victoria Brandt

Date: August 24, 2012

Reviewed By: Roger K Tripp

Date: 8/24/12

Date Printed: 8/24/2012
Version 1.5.2

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
RADIOLOGIC HEALTH BRANCH
1500 Capitol Avenue, Sacramento, CA

Detector Efficiency

Meter:	Mfg. **Ludlum**	Model: **2221**	Serial # **163683**	Calibration Date:	24-Aug-2012
Detector:	Mfg. **Ludlum**	Model: **44-10**	Serial # **PR169437**	Due Date:	**Aug 2013**

NIST TRACEABLE SOURCES

Isotope		Serial #	Cert. Date	Activity	Units	DPM
Am-241	γ	5588	3/1/2001	1.075	µCi	2343013
Ba-133	γ	5589	3/1/2001	1.048	µCi	1093539
Cs-137	γ	5590	3/1/2001	1.010	µCi	1722377
Co-60	γ	5587	3/1/2001	1.073	µCi	523383

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology or to Physikalisch-Technische Bundesanstalt (PTE), to the extent allowed by the Institute's calibration facilities.

EFFICIENCY CALCULATIONS

Source Distance: 0.5 in.

Background Measurement γ cpm		**Isotope: Am-241** Measurement γ cpm	**Isotope: Ba-133** Measurement γ cpm	**Isotope: Cs-137** Measurement γ cpm	**Isotope: Co-60** Measurement γ cpm
6000	**1**	170000	300000	170000	90000
6500	**2**	175000	350000	175000	90000
6000	**3**	170000	300000	170000	85000
7000	**4**	170000	300000	165000	90000
6500	**5**	175000	350000	170000	95000
6400	**Average (cpm)**	**172000**	**320000**	**170000**	**90000**
418	**Std. Dev. (cpm)**	2739	27386	3536	3536
	Net Efficiency	0.07068 (cpm) /dpm	0.2868 (cpm) /dpm	0.09499 (cpm) /dpm	0.1597 (cpm) /dpm

% Efficiency	7.07%	for	Am-241	γ
% Efficiency	28.7%	for	Ba-133	γ
% Efficiency	9.50%	for	Cs-137	γ
% Efficiency	16.0%	for	Co-60	γ

COMMENTS: Emission (DPM) is decayed to printing date.
Alpha and beta source distance is 0.25 inch (6.4 mm). Gamma source distance is 0.5 inch (12.7 mm).

Health Physicist: Victoria L Brandt
Victoria Brandt
Date: August 24, 2012

Reviewed By: Roger K Lyon
Date: 8/24/12

Date Printed: 8/24/2012
Version 1.5.2

Appendix B: SAMPLE ANALYSIS AND RESULTS

Table 14: Laboratory Results Summary

Descriptive Name	Sample ID	Field Measurement (mR/hr)	Cs-137 Sample (pCi/g)	Cs-137 MDA_{95} (pCi/g)	Ra-226 (Bi-214, 609 keV) Sample (pCi/g)	Ra-226 (Bi-214, 609 keV) MDA_{95} (pCi/g)	K-40 Sample (pCi/g)	K-40 MDA_{95} (pCi/g)
Pre- Remediation: Collected 3/20/2013								
Treasure Island, Site 12, Sample A	R98805	3.5	-0.235 ± 0.105	1.11	7897 ± 166	1.78	6.53 ± 3.22	12.0
Treasure Island, Site 12, Sample B	R98806	0.45	0.0225 ± 0.13	0.119	100 ± 2	0.339	10.6 ± 0.4	1.41
Treasure Island, Site 12, Sample C	R98807	0.41	0.0177±0.0190	0.104	75.8 ± 2	0.295	9.49 ± 0.34	1.17
Treasure Island, Site 12, Sample D	R98808	0.10	0.231 ± 0.003	0.0143	0.642 ± 0.022	0.066	9.31 ± 0.23	0.234
TI Sample E /Bottom of sod 11 cm depth	R98804	0.15	-0.0638±0.048	0.251	405 ± 8.5	0.335	9.83 ± 0.56	2.34
TI Sample E "Bottom" (20 cm depth)	R98803	0.11	-0.0285±0.014	0.0678	30.0 ± 0.6	0.162	10.4 ± 0.3	0.672
During Remediation: Collected 3/21/2013								
TI Sample A – During remediation	R96216	-----	-0.141±0.0485	0.301	706 ± 14.9	0.429	10.6 ± 1.2	5.37
Post-Remediation: Collected 3/21/2013								
TI Sample A – Post Remediation	R96217	-----	-0.000294 ± 0.00462	0.0204	1.016 ± 0.028	0.0674	10.3 ± 0.2	0.255
TI Sample B – Post Remediation	R96218	-----	0.355 ± 0.003	0.0164	3.36 ± 0.07	0.0835	$10.2 \pm 0.2_5$	0.288
TI Sample C – Post Remediation	R96219	-----	< MDA	0.0724	38.0 ± 0.8	0.208	9.89 ± 0.29	0.821
TI Sample E – Post Remediation	R96215	-----	0.00570 ± 0.00735	0.0368	6.79 ± 0.15	0.110	10.9 ± 0.3	0.387

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FINAL Analysis Results Report for Task ID. 13-0214

Investigator: Victoria Brandt RHB PO box 997414.MS 7610 Sacramento CA 95899 Phone Number: 916 440-7955	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Site 12	
System No: Billing Agency: RHB	Samples Received by Lab: 3/21/2013

Lab No: 13-0214-01 Sample ID: R 98805 Time Collected: 3/20/2013 13:06 Sampling Point: Sample A
Sample Type: Soil/Sediment

Parameter	Method	Result +/- CE	MDA 95	Units
Dry Wt/Wet Wt		0.933		
Cs-137	HASL Ga-01-R	-0.235 +/- 0.105	1.11	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	7897 +/- 166	1.78	pCi/g dry wt.
K-40	HASL Ga-01-R	6.53 +/- 3.22	12.0	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.
(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.
(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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FINAL Analysis Results Report for Task ID. 13-0215

Investigator: Victoria Brandt RHB PO box 997414.MS 7610 Sacramento CA 95899 Phone Number: 916 440-7955	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Site 12	
System No: Billing Agency: RHB	Samples Received by Lab: 3/21/2013

Lab No: 13-0215-01 Sample ID: R 98806 Sample Type: Soil/Sediment Time Collected: 3/20/2013 13:24 Sampling Point: Sample B

Parameter	Method	Result +/- CE	MDA 95	Units
Dry Wt/Wet Wt		0.947		
Cs-137	HASL Ga-01-R	0.0225 +/- 0.0134	0.119	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	100 +/- 2.12	0.339	pCi/g dry wt.
K-40	HASL Ga-01-R	10.6 +/- 0.394	1.41	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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FINAL Analysis Results Report for Task ID. 13-0216

Investigator: Victoria Brandt RHB PO box 997414.MS 7610 Sacramento CA 95899 Phone Number: 916 440-7955	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Site 12	
System No: Billing Agency: RHB	Samples Received by Lab: 3/21/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0216-01 Sample ID: R 98807 Sample Type: Soil/Sediment	Time Collected: 3/20/2013 13:33	Sampling Point: Sample C		
Dry Wt/Wet Wt		0.910		
Cs-137	HASL Ga-01-R	0.0177 +/- 0.0190	0.104	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	75.8 +/- 1.60	0.295	pCi/g dry wt.
K-40	HASL Ga-01-R	9.49 +/- 0.339	1.17	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radionuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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FINAL Analysis Results Report for Task ID. 13-0217

Investigator: Victoria Brandt RHB PO box 997414.MS 7610 Sacramento CA 95899 Phone Number: 916 440-7955	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Site 12	
System No: Billing Agency: RHB	Samples Received by Lab: 3/21/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0217-01 Sample ID: R 98808 Sample Type: Soil/Sediment	Time Collected: 3/20/2013 13:37	Sampling Point: Sample D		
Dry Wt/Wet Wt		0.940		
Cs-137	HASL Ga-01-R	0.0231 +/- 0.00333	0.0143	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	0.642 +/- 0.0219	0.066	pCi/g dry wt.
K-40	HASL Ga-01-R	9.31 +/- 0.229	0.234	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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FINAL Analysis Results Report for Task ID. 13-0213

Investigator: Victoria Brandt RHB PO box 997414.MS 7610 Sacramento CA 95899 Phone Number: 916 440-7955	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Sample E	
System No: Billing Agency: RHB	Samples Received by Lab: 3/21/2013

Lab No: 13-0213-01 Sample ID: R 98803 Time Collected: 3/20/2013 10:38 Sampling Point: Sample E "Bottom"
Sample Type: Soil/Sediment

Parameter	Method	Result +/- CE	MDA 95	Units
Dry Wt/Wet Wt		0.919		
Cs-137	HASL Ga-01-R	-0.0285 +/- 0.0142	0.0678	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	30.0 +/- 0.636	0.162	pCi/g dry wt.
K-40	HASL Ga-01-R	10.4 +/- 0.287	0.672	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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California Department of Public Health

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FINAL Analysis Results Report for Task ID. 13-0212

Investigator: Victoria Brandt RHB PO box 997414.MS 7610 Sacramento CA 95899 Phone Number: 916 440-7955	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Bottom of sod, 11 cm depth	
System No: Billing Agency: RHB	Samples Received by Lab: 3/21/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0212-01	Sample ID: R 98804 Sample Type: Soil/Sediment	Time Collected: 3/20/2013 10:50	Sampling Point: Sample E	
Dry Wt/Wet Wt		0.886		
Cs-137	HASL Ga-01-R	-0.0638 +/- 0.0485	0.251	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	405 +/- 8.50	0.335	pCi/g dry wt.
K-40	HASL Ga-01-R	9.83 +/- 0.555	2.34	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radionuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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FINAL Analysis Results Report for Task ID. 13-0220

Investigator: Jeff Wong RHB	Requestor: Roger Lupo RHB
CDPH, 850 Marina Bay Parkway	CDPH - RHB, 1500 Capitol Av., MS 7610
Richmond CA 94804	Sacramento CA 95814-5006
Phone Number: 510-620-3423	Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Bldg 1303	
System No: Billing Agency: RHB	Samples Received by Lab: 3/22/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0220-01 Sample ID: R 96216 Sample Type: Soil/Sediment	Time Collected: 3/21/2013 10:42		Sampling Point: Sample A-During remediation	
Dry Wt/Wet Wt		0.9324		
Cs-137	HASL Ga-01-R	-0.141 +/- 0.0601	0.310	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	706 +/- 14.9	0.429	pCi/g dry wt.
K-40	HASL Ga-01-R	10.6 +/- 1.18	5.37	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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FINAL Analysis Results Report for Task ID. 13-0221

Investigator: Jeff Wong RHB	Requestor: Roger Lupo RHB
CDPH, 850 Marina Bay Parkway	CDPH - RHB, 1500 Capitol Av., MS 7610
Richmond CA 94804	Sacramento CA 95814-5006
Phone Number: 510-620-3423	Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Bldg 1303	
System No: Billing Agency: RHB	Samples Received by Lab: 3/22/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0221-01 Sample ID: R 96217 Sample Type: Soil/Sediment	Time Collected: 3/21/2013 10:56		Sampling Point: Sample A-Post remediation	
Dry Wt/Wet Wt		0.9278		
Cs-137	HASL Ga-01-R	-0.000294 +/- 0.00462	0.0204	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	1.016 +/- 0.0284	0.0674	pCi/g dry wt.
K-40	HASL Ga-01-R	10.3 +/- 0.251	0.255	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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California Department of Public Health

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FINAL Analysis Results Report for Task ID. 13-0222

Investigator: Jeff Wong RHB CDPH, 850 Marina Bay Parkway Richmond CA 94804 Phone Number: 510-620-3423	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Bldg 1303	
System No: Billing Agency: RHB	Samples Received by Lab: 3/22/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0222-01 Sample ID: R 96218 Sample Type: Soil/Sediment	Time Collected: 3/21/2013 11:26		Sampling Point: Sample B- Post Remediation	
Dry Wt/Wet Wt		0.9597		
Cs-137	HASL Ga-01-R	0.0355 +/- 0.00275	0.0164	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	3.36 +/- 0.0758	0.0835	pCi/g dry wt.
K-40	HASL Ga-01-R	10.2 +/- 0.249	0.288	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

State of California - Health and Human Services Agency
California Department of Public Health

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FINAL Analysis Results Report for Task ID. 13-0223

Investigator: Jeff Wong RHB CDPH, 850 Marina Bay Parkway Richmond CA 94804 Phone Number: 510-620-3423	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Bldg 1306	
System No: Billing Agency: RHB	Samples Received by Lab: 3/22/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0223-01 Sample ID: R 96219 Sample Type: Soil/Sediment	Time Collected: 3/21/2013 12:25	Sampling Point: Sample C-Post Remediation		
Dry Wt/Wet Wt		0.9494		
Cs-137	HASL Ga-01-R	0.0148 +/- 0.00880	0.0724	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	38.0 +/- 0.802	0.208	pCi/g dry wt.
K-40	HASL Ga-01-R	9.89 +/- 0.293	0.821	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

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FINAL Analysis Results Report for Task ID. 13-0219

Investigator: Jeff Wong RHB CDPH, 850 Marina Bay Parkway Richmond CA 94804 Phone Number: 510-620-3423	Requestor: Roger Lupo RHB CDPH - RHB, 1500 Capitol Av., MS 7610 Sacramento CA 95814-5006 Phone Number: 916-440-7955
Site/Project Name: Treasure Island / Bldg 1128	
System No: Billing Agency: RHB	Samples Received by Lab: 3/22/2013

Parameter	Method	Result +/- CE	MDA 95	Units
Lab No: 13-0219-01 Sample ID: R 96215 Sample Type: Soil/Sediment	Time Collected: 3/20/2013 12:20		Sampling Point: Sample E-Post Remediation	
Dry Wt/Wet Wt		0.8991		
Cs-137	HASL Ga-01-R	0.00570 +/- 0.00735	0.0368	pCi/g dry wt.
Ra-226 (Bi-214, 609 keV)	HASL Ga-01-R	6.79 +/- 0.149	0.110	pCi/g dry wt.
K-40	HASL Ga-01-R	10.9 +/- 0.272	0.387	pCi/g dry wt

(1) Precision criteria for these method were determined to be acceptable.

(2) CE is the counting error at the 95% confidence level as defined in Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.

(3) MDA95 is the sample specific minimum detectable activity at the 95% confidence level which is the LLD95 devided by 2.22, the efficiency, and the yield, and may include factors for abundance, decay, and ingrowth, dependent on the particilar radio-nuclide. LLD95 is defined in section 7010G, Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Ed., 2005, where Sb is the aquare root of the instrument background count rate.

Appendix C: VARSKIN ANALYSIS

Varskin 4

Date: 7/1/2013 Time: 8:19:34 AM

Treasure Island Location E March 2013 Source Activity

Disk Source Geometry

Source Diameter: 1.50E+00 cm

Source Area: 1.77E+00 cm^2

Irradiation Time: 1.00E+00 hr

Irradiation Area: 1.00E+00 cm^2

Skin density thickness: 7.00E+00 mg/cm^2

Air Gap Thickness: 2.00E-01 cm

RESULTS FROM ALL SOURCES

	Initial Dose Rate	Dose (No Decay)	Decay-Corrected Dose
Beta	2.79E+02 rad/h	2.79E+02 rad	1.74E+02 rad
Photon	1.18E+00 rad/h	1.18E+00 rad	6.71E-01 rad
Total	2.80E+02 rad/h	2.80E+02 rad	1.74E+02 rad

RESULTS FROM INDIVIDUAL SOURCES

Nuclide: Bi-214

Half Life: 0.3316667 h

Average Beta Energy: 0.6134564 MeV

X-99 Distance: 0.5035018 cm

Source Strength: 3.10E-02 mCi/cm^2

	Initial Dose Rate	Dose (No Decay)	Decay-Corrected Dose
Beta	7.32E+01 rad/h	7.32E+01 rad	3.08E+01 rad
Photon	5.99E-01 rad/h	5.99E-01 rad	2.52E-01 rad
Total	7.38E+01 rad/h	7.38E+01 rad	3.10E+01 rad

Nuclide: Pb-214

Half Life: 0.4466667 h

Average Beta Energy: 0.1317466 MeV

X-99 Distance: 0.09770415 cm

Source Strength: 3.10E-02 mCi/cm^2

	Initial Dose Rate	Dose (No Decay)	Decay-Corrected Dose
Beta	1.27E+02 rad/h	1.27E+02 rad	6.45E+01 rad
Photon	3.31E-01 rad/h	3.31E-01 rad	1.68E-01 rad
Total	1.27E+02 rad/h	1.27E+02 rad	6.46E+01 rad

Nuclide: Pb-210

Half Life: 195481.8 h

Average Beta Energy: 0.011949834 MeV
X-99 Distance: 0.0019008148 cm
Source Strength: 3.10E-02 mCi/cm^2

	Initial Dose Rate	Dose (No Decay)	Decay-Corrected Dose
Beta	0.00E+00 rad/h	0.00E+00 rad	0.00E+00 rad
Photon	2.51E-01 rad/h	2.51E-01 rad	2.51E-01 rad
Total	2.51E-01 rad/h	2.51E-01 rad	2.51E-01 rad

Nuclide: Bi-210
Half Life: 120.288 h
Average Beta Energy: 0.3890079 MeV
X-99 Distance: 0.2046475 cm
Source Strength: 3.10E-02 mCi/cm^2

	Initial Dose Rate	Dose (No Decay)	Decay-Corrected Dose
Beta	7.88E+01 rad/h	7.88E+01 rad	7.86E+01 rad
Photon	0.00E+00 rad/h	0.00E+00 rad	0.00E+00 rad
Total	7.88E+01 rad/h	7.88E+01 rad	7.86E+01 rad